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THE WEATHERED CRUST AND HYDROTHERMAL FORMATIONS ALONG THE BATUMI COAST OF THE CAUCASUS

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The Batumi weathered crust has long attracted the attention of researchers, not only as a formation of Quaternary age, which is still in the development stage, but also as a major geological body, whose development has taken place under conditions of complex actively developing relief of the Alpine folded zone. As is well known, all other well-developed weathered crusts in the territory of the Soviet Union, are associated exclusively with platform structures and were formed on slowly rising peneplaned plateaus [1, 2]. The possibility of forming a weathered crust of corresponding thickness under the condition of dissected relief along the Batumi coast was an extremely unusual phenomenon and until now has been attributed to the existence in this region of an epoch of peneplanation and the protective effect of a dense subtropical vegetation.

Our investigations revealed that the Batumi weathered crust is not an ordinary weathered crust of the Ural type, but is a complex polygenic formation, in whose formation a role was played not only by surface weathering and soil-formation processes, but also by postmagmatic hydrothermal processes.

It was found that in the classical cross section of the Chakva River the clayey and grus products lying on the basaltic rocks under "red earths" of kaolinic composition (Figure 1) do not constitute the lower horizons of the weathered crust profile, as has been assumed until now, but instead are clayey metasomatites of postmagmatic hydrothermal origin.

Proofs of the hydrothermal genesis of iron-bearing Al-Mg montmorillonite clays of the lower horizon of the Chakva River cross section (described initially by N. A. Lisitsina [3] and the author [4] as hydrochloritic eluvium) are as follows:

1. A close spatial correlation between the clayey formations of this type and a complex of bentonitic clays of the Upper Eocene, whose hydrothermal genesis was demonstrated by G. A. Tvalchrelizde, G. S. Dzotsenidze and N. I. Skhartaladze [5] in the example of the Askanskoye bentonitic deposits, situated nearby.

2. The composition of rock-forming clay minerals, unusual for weathered crusts. The principal component of the structured clays of basaltic rocks along the Chakva River is trioctahedral iron-bearing Al-Mg-montmorillonite (d_{001} = 14.6 A, in glycerin 17.6-18.85 A; at 550° 9.6 A; d_{060} = 1.537-1.539 A), a mineral characteristic both for autometamorphically and hydrothermally modified basaltic rocks. However, in weathered crusts minerals of the montmorillonite group are always represented by dioctahedral aluminum montmorillonite ($4SiO_2 \cdot Al_2O_3 \cdot nH_2O$ with d_{060} = 1.49 A) and varieties, transitional to trioctahedral ferrimontmorillonites with Fe^{3+} in the lattice but poor in Mg^{2+} ($4SiO_2(Al, Fe)_2O_3 \cdot nH_2O$ with d_{060} = 1.50 A) or nontronites ($4SiO_2Fe_2O_3 \cdot nH_2O$ with d_{060} = 1.52 A).

3. The development of trioctahedral Al-Mg-montmorillonite not only from dark-colored (augite and hornblende) and chlorite-like minerals of the basaltic rocks, but also from feldspars, a phenomenon never observed in weathered crusts, since iron-bearing Al-Mg-montmorillonite cannot be obtained from plagioclase by simple leaching without addition of Fe^{3+} and Mg^{2+}.

4. The presence in rocks completely decomposed to clay of completely fresh augite phenocrysts, which have not been subjected to decomposition. In weathered crusts the dark-colored minerals are decomposed during the initial stages of weathering, whereas in both hydrothermally modified tuffs and lavas dark-colored minerals frequently remain unmodified. These data are also confirmed by the fact that during the formation of both red and brown eluvium (see Figure 1) in iron-bearing Al-Mg-montmorillonite clays, in such cases, as along the Batumi coast, augite is decomposed primarily with the formation of a residual goethitic framework.

Thus, in the Chakva River cross section, only the upper, red-colored kaolinitic horizon, crowning the cross section, constitutes the weathered crust (see Figure 1, layer 3), whereas the dense basaltic nuclei, brittle greenish clayey rocks of the lower horizons in the cross

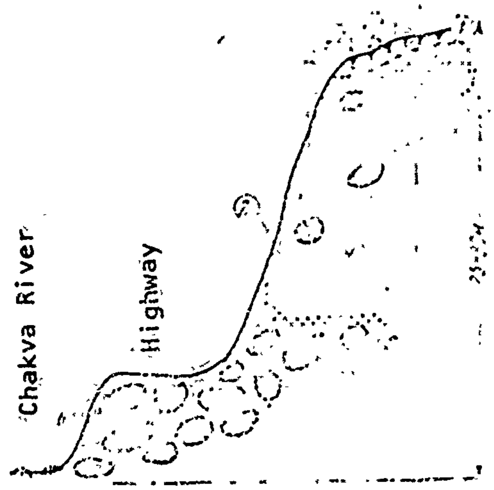

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Figure 1. Cross section of right bank of Chakva River, near Georgidze Village. 1, Present-day soil, brown, clayey loam of the deluvial type, containing humus, 0.1-0.6 m thick; 2, Present-day brown eluvium on slopes, well-expressed brown clayey ochre of hydro-goethitic-kaolinitic composition; 3, Raspberry-red kaolins with nuclei of dense amygdaloidal basalt, up to 3-4 m thick; 4, Greenish brittle montmorillonite clays with a relict structure of hyaloclastite and with phenocrysts of fresh augite holding nuclei of dense amygdaloidal basalt, up to 8-10 m thick; 5, Grus of chloritic hyaloclastite with nuclei of dense amygdaloidal basalt, up to 5-6 m thick; 6, Dense spherical basaltic lavas with chloritic hyaloclastite in concentrates and in spaces between spheres, apparent thickness 2-3 m.

section, rich in augite phenocrysts, constitutes clayey metasomatites of hydrothermal origin which have been exposed at the surface and subjected to weathering. Accordingly, the parent rocks of the weathered crust along the Chakva River are not igneous bedrocks, but structured Al-Mg-montmorillonite clays of hydrothermal genesis, rich in pyroxene, lying on dense spherical (spherulitic) basaltic lavas. The residual thickness of the raspberry-red kaolinic eluvium crowning the Chakva River cross section, does not exceed 3-4 m; however, the thickness of the entire clayey stratum, including the clayey metasomatites of hydrothermal origin is 20-25 m.

Two strata, in contact with one another rich in volcanoclastic material, were subjected to hydrothermal argillization in the Batumi region: a porphyritic suite of the Middle Eocene and a trachytic suite of the Upper Eocene.

The hydrothermal genesis of Al-montmorillonite clays of the trachytic suite, as noted above, was established by A. A. Tvalchrelidze, G. S. Dzotsenizde and N. I. Skhartladze [5] and was later confirmed by G. S. Dzotsenizde [6] for the region of the Askanskoye bentonitic deposit, situated to the east of Makharadze. The Al-montmorillonite clays developed farther south, in the Kobuletsko-Makharadzevskiy region, have the same genesis, but here in the region of development of "Batumi red earths" they have already been described as products of the weathered crust.

In the complex of rocks of the porphyritic suite along the Chakva River, it was mostly hyaloclastites with nuclei of basaltic rocks, products of fragmentation of basaltic lavas forming during the process of rapid cooling of viscous basaltic melt upon contact with sea water, lying on dense spherical (spherulitic) lavas, which were montmorillonitized [9]. Under water, it was glassy hyaloclastitic material which for the most part was subjected to autometamorphic modification, whereas the relatively well-crystallized basaltic nuclei included within it remained only slightly modified. Accordingly, later, during the hydrothermal argillization of spherulitic basaltic lavas, rich in hyaloclastitic material, the hyaloclastitic mass, decomposed with the formation of chlorite-like products, was subjected to montmorillonitization, whereas the well-crystallized basaltic spherules included within it remained as before both dense and unmodified.

The weathering processes superposed on this hydrothermally worked stratum, as well as the processes of hydrothermal leaching, developed in the most porous rocks, in this case in the structured Al-Mg-montmorillonite clays (porosity 40-45%), leaving the dense basaltic spherules (porosity 8-10%) unaffected. As a result of this selective process, reddish and brownish eluvial products of kaolinic composition developed which incorporate nuclei of dense unmodified basaltic rocks.

The erosion of clayey metasomatites in the Batumi area and the formation of eluvium and soils on them evidently began from the Middle Pleistocene (from the Post-Bakinskaya orogenic phase), from the time of formation of the principal forms of present-day relief [6]. The weathering and soil-forming processes along the Batumi coast also involved the Pleistocene-Holocene terraces. The degree of weathering of the terrace deposits varies in a very broad range and is determined to a considerable degree by the primary composition of the rocks forming them. The terrace deposits of the region of development of metasomatites, rich in sandy-silty material of hydrothermally modified rocks, were decomposed particularly well. An example is the terrace deposits of the Kentrish River, described by A. G. Chernyakhovskiy [10].

The weathered crust of the Batumi coast of the Caucasus can be defined into a new independent type under the name "pseudozonal" or "Batumi." In such crusts the upper kaolinic horizon is eluvial, whereas the role of an "intermediate" zone of the profile is played by clayey

formations of hydrothermal origin. It is frequently very difficult to distinguish pseudozonal crusts from real zonally constructed weathered crusts (of the Ural type) because we cannot always distinguish the weathered products from hydrothermal metasomatites. The mineralogical similarity of such genetically different formations can be attributed to a considerable degree to the fact that in the postmagmatic hydrothermal argillization of rocks, transpiring near the surface, a role is played by surface stratum water of water-bearing horizons.

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13. ABSTRACT

Studies by the author revealed that the Batumi weathered crust is not an ordinary weathered crust of the Ural type, but constitutes a complex polygenic formation in whose formation a role was played not only by surface weathering and soil-forming processes, but also by postmagmatic hydrothermal processes.

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